Ewing Fuels Reduction
Fire, Fuels, and Air Quality Report

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Background

This project is focused on an isolated 40 acre parcel of USFS land near Ewing Reservoir (T31N, R11W, Section 7). The parcel is bounded by Bureau of Land Management land to the north and east and private land to the west and south. Approximately 10 acres in the southwest corner of the parcel is under special use permit to the Trinity County Waterworks District. The entire parcel is located within the wildland urban interface, and approximately half of the parcel is with the defense zone of the WUI (which includes area within .25 miles of structures).

The project is located in the Hayfork Management Area (Management Area 18). The management prescription from the Shasta-Trinity National Forest Land and Resource Management Plan is Prescription III (Roaded Recreation). The proposed action occurs within the Hayfork Adaptive Management Area.

Methodology

The analysis for this report relies on fire behavior modeling to quantify the effects of the proposed action. From a fire behavior perspective, vegetation can be described in terms of fuels. Surface fuels are comprised of grasses, forbs, shrubs, needle/leaf litter, shrubs and downed woody debris. The various combinations of surface fuels are described by fuel models that generalize surface fuels into functional categories for use in the fire behavior models. Forest canopy characteristics (canopy base height, canopy bulk density, canopy height, and canopy cover) are also used in fire behavior modeling to determine whether fire can spread vertically from the surface to the canopy (crown fire initiation/passive crown fire/torching), as well as whether it can spread horizontally through the canopy (active crown fire).

Current conditions (fuel models and canopy characteristics) were obtained from LANDFIRE (a database of landscape data generated through remote sensing and refined by field verification and professional judgement) and were validated in the field. Corrections to the fuel model data for the analysis area were based on experience and professional judgement. Predictions of post-treatment fuel models and canopy characteristics were also based on professional judgement and experience with wildland fire in similar fuel types and were validated with the Interagency Fuel Treatment Decision Support System (IFTDSS).

Fire behavior predictions were generated using FlamMap (Finney 2006), a fire behavior analysis and mapping program that predicts a variety of fire behavior characteristics for individual pixels across a landscape. Because LANDFIRE data exists as a 30-meter pixel resolution, FlamMap outputs are generated for 30-meter pixels, each containing data regarding surface fuel model, canopy fuel charateristics, and topography (elevation, slope, and aspect). Topographic characteristics were also obtained from LANDFIRE.

For modeling purposes, historic fuel moisture and weather conditions were used to model future conditions. 90th percentile fuel moisture conditions were used to predict fire behavior in the project area. Fuel moistures were obtained from the Percentile Weather function of the Fire

Family Plus (Main et al. 1990) program using data collected by the Hayfork Remote Automated Weather Station (RAWS) during the period of May 1 to October 31 from 2008 to 2017. The values represent the actual combination of fuel moistures that have resulted in an Energy Release Component (an index within the National Fire Danger Rating System used to measure seasonal-scale trends in fire danger) in the 90th percentile. In other words, the values used have occurred on only 10 percent of the fire-season days between 2008 and 2017. The intent is to capture the worst case scenario conditions that would test the efficacy of the proposed action in meeting the purpose and need. Fire Family Plus was also used to analyze historic wind patterns based on hourly observations from 1200 to 1900, between May 1 and October 31, 2008 to 2017, at the Hayfork RAWS. The 90th percentile wind speed (converted from 10-minute average to 1 minute average) is 11 miles per hour (Crosby and Chandler 1966). A wind rose analysis demonstrated that strong winds typically occur out of the west. Table 1 displays the values used for analysis.

Table 1. 90th Percentile Fuel Moisture & Wind Parameters

Parameter	**Value**
1-hour fuel moisture (0 to 0.25 inch diameter)	3%
10-hour fuel moisture (0.25 to 1 inch diameter)	4%
100-hour fuel moisture (1 to 3 inch diameter)	10%
1000-hour fuel moisture (3 inch plus diameter, CWD)	10%
Herbaceous fuel moisture	30%
Woody fuel moisture	72%
20-foot wind speed, direction	11 miles per hour, 270 degrees

Fire behavior in this analysis is described in terms of flame length and fire type (surface, torching, crown). Fireline intensity is the rate of energy release per unit length of flaming front, and flame length is the measurement related to fireline intensity that can be easily visualized or measured in the field (Sugihara et al., 2006). Increased flame lengths can increase the likelihood of torching and crown fire. Flame length is influenced by fuel type, fuel loading, fuel arrangement, fuel moisture, and weather conditions. Flame length and fireline intensity influence production rates, or how fast firelines can be constructed by different suppression resources, including hand crews and mechanical equipment. Flame lengths over 4 feet, or fireline intensities over 100 BTU per foot per second, may present serious control problems. These conditions are too dangerous to be directly contained by hand crews (Schlobohm and Brain 2002; Andrews and Rothermel 1982). Flame lengths over 8 feet, or fireline intensities over 500 BTU per foot per second, are generally not controllable by ground-based equipment or aerial retardant, and present serious control problems including torching, crowning, and spotting. Flame length and fireline intensity directly affect suppression tactics. Table 2 outlines how flame lengths and fireline intensities influence fire suppression actions (Andrews et al. 2011).

Table 2. Relationship Between Flame Length, Fireline Intensity, and Suppression Actions

Flame length		**Fireline intensity**		**Suppression Actions**
Feet	**Meters**	**Btu/ft/s**	**kJ/m/s**	
< 4	< 1.2	< 100	<350	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.

Flame length		Fireline intensity		Suppression Actions
Feet	Meters	Btu/ft/s	kJ/m/s	
4 – 8	1.2 – 2.4	100 – 500	350 – 1700	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
8 – 11	2.4 – 3.4	500 – 1000	1700 – 3500	Fires may present serious control problems—torching, crowning, and spotting. Control efforts at the fire head will probably be ineffective
> 11	> 3.4	> 1000	> 3500	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Prescribed fire has effects to air quality in the form of emissions of criteria pollutants and greenhouse gasses as well as potential contributions to regional haze. Ambient Air Quality Standards were considered for this project. Trinity County is identified as attainment or unclassified for ozone, carbon monoxide, sulfur oxides, lead, respirable particulate matter, and fine particulate matter (criteria pollutants) for both state and federal standards; under the General Conformity regulations, no further analysis is required. The project is over 25 miles from the nearest Class I airshed (Yolla Bolly Middle Eel Wilderness). The small size of the project area, its distance from the nearest class 1 airshed, the probable occurrence of prescribed fire activities outside of the peak of the summer fire season (when regional haze is highest), and the relatively short duration of prescribed fire activities (one to several consecutive days) are unlikely to impede the progress of the California Regional Haze Plan. Therefore, no further analysis is needed. Prescribed burning activities release greenhouse gasses (GHGs) that can contribute to climate change. There are currently no thresholds for greenhouse gas emissions for prescribed burning. Emissions of various greenhouse gasses are generally expressed in metric tons of carbon dioxide equivalent. Modeling of emissions was completed using the First Order Fire Effects Monitoring (FOFEM), version 6.4 software application. Emission calculations were generated for an Oregon White-Oak / Douglas-fir vegetation type burning under the default conditions for both dry, fall burn and very dry wildfire scenarios. Conversion factors from the Intergovernmental Panel on Climate Change were used to calculate total metric tons of carbon dioxide equivalent (IPCC 2007).

Existing Condition

The majority of the parcel contains no record of fire in the last 107 years. A small portion of the parcel burned within the last 10 years. The pre-fire-suppression period mean fire return interval for the vegetation types found in the parcel is 16 years, meaning the area has missed several fires. The lack of fire has allowed an increase in surface and ladder fuels below the overly dense conifer stands and has created uniform fields of decadent brush in the open pine and oak woodland areas. Pockets of conifer mortality have developed within the parcel. The hazardous fuel profiles could contribute to a future wildfire’s high-intensity fire behavior, high-severity fire effects, and elevated resistance to control in an area within the defense zone of the wildland urban interface and adjacent to Hayfork’s municipal water supply and water treatment infrastructure.

Desired Future Condition

The desired fuel profiles would limit fire behavior to surface fire and reduce the probability of crown fire initiation and propagation under the 90th percentile fuel moisture and weather conditions common in mid- to late-summer. The desired fuel profiles would have discontinuous surface fuel loading (to reduce potential flame length), disconnected ladder fuels (to limit the possibility of torching), increased canopy spacing (to limit crown fire spread), and retention of large trees of fire resilient species (to reduce post-fire mortality and restore historic stand structure) (Agee and Skinner 2005). The desired condition would also increase the likelihood that firefighters could safely and effectively engage a fire directly with hand tools, engines, dozers, and aircraft.

The desired stand conditions would allow for safe reintroduction of fire and would be more resilient to wildfire and endemic levels of disease and insect activity. The desired condition would reduce encroachment by brush and shade-tolerant conifers on oak woodlands and improve oak vigor and mast production. The desired condition for brushfields would reduce total cover of decadent brush, which would result in increased access for wildlife and improved browse production (Skinner 1995).

Purpose and Need:

The purpose of this project is to reduce fuel accumulation and reintroduce fire as an ecological process to

- increase fire suppression capabilities,
- provide for firefighter and public safety,
- mitigate risk to communities and infrastructure,
- improve vegetation resilience, and
- improve wildlife habitat

The need for this project arises from its location along the boundary between public and private lands, where unplanned wildfire under the existing conditions could threaten safety, infrastructure, and natural resources. The onset of tree mortality in the parcel also drives the need, as it highlights the increased stress and declining resilience in the vegetation. A secondary need for the project is to coordinate fuel reduction activities with the Bureau of Land Management and adjacent landowners. Coordinated, interagency prescribed fire along or across jurisdictional boundaries could assist both agencies in achieving desired conditions. Fuel reduction work has occurred on adjacent private land to the south, and the opportunity exists for partnerships that match fuels management efforts.

Proposed Action:

The project proposes to reduce fuels by modifying fuel profiles within the parcel through a combination of the following activities:

- broadcast burning (which will include construction of control lines by using hand tools to clear litter and duff down to mineral soil and to a width of approximately 2 feet)
- hand thinning dense pockets of small trees (up to 8 inches DBH, thinned to approximately 20-ft spacing)
- pruning residual tree crowns to a canopy base height of up to 8’ and hand piling or scattering (within broadcast units) the material
- cutting live and dead brush to be hand piled or scattered (within broadcast burn units) in order to create a mosaic of brush with a target clump size of 10 feet diameter or less and approximately 20 – 30 feet of spacing between shrubs or clumps of shrubs, and an average shrub height of 24 inches or less

- removing brush and small trees from under the driplines of residual trees.
- cutting and hand piling dead and down fuels, thinned trees, pruned limbs, and live brush into piles that average 6’x6’
- felling of trees that pose a hazard to the public, personnel, or property
- chipping and/or machine piling felled hazard trees into piles averaging 10’x10’(within an approximately 2 acre portion of the special use permit area; see project maps)
- burning hand piles
- burning machine piles and/or jackpot burning portions of felled hazard trees

The primary activity within the project area will be broadcast prescribed fire. The other activities will be utilized

- in areas where broadcast burning is not feasible,
- to create buffers of reduced fuel adjacent to private property prior to future broadcast burning, and
- to moderate the potential effects of broadcast burning.

The majority of the 40-acre parcel would be included in the broadcast burn. Some topographical features that could function as the logical locations for control lines are outside the USFS parcel, on BLM land. Potions of the parcel could be burned along with BLM land. The parcel could be broadcast burned as a whole or be separated into smaller sub-units. Specific prescribed fire objectives will be established in prescribed fire burn plans for units within the project area; however, the following are general fuel reduction targets:

- Reduce average surface litter 20-75% over the entire project area immediately post-burn
- Reduce average 10- and 100-hr surface fuels 10-75% immediately post-burn
- Reduce average 1000-hr fuels 5-50% immediately post-burn (may be higher for areas of significant tree mortality)
- Reduce average mature live shrub cover 20-80% immediately post-burn

The project is planned for implementation over the course of one to five years; however, implementation may be delayed by unforeseen events.

Fuels Reduction Maintenance

The treatments will be maintained, primarily by broadcast burning, within ten years of the initial treatment. Maintenance treatments could also include the full range of activities outlined in the initial treatment.

Monitoring

Monitoring of the effects of the proposed action will be conducted in accordance with the Forest’s current fuels and fire effects monitoring protocols.

Environmental Consequences

Direct and Indirect Effects

The proposed action is expected to meet the desired condition by disrupting the current horizontal and vertical continuity of fuels and reducing the potential fire behavior under 90th percentile conditions. Table 4 describes the anticipated effects of treatment. The primary shifts in fuel model are from dense, tall shrubs to a more open combination of grass and lower shrubs as well as a shift to a lighter accumulation of surface litter in the mixed conifer stand. Existing conditions could result in flame lengths up to 43 feet, and nearly half of the project area could experience flame lengths over 11 feet. The proposed action is expected to limit flame lengths to no more than 6.5 feet, meaning that engines, dozers, and aircraft would likely be effective in suppressing fires throughout the project area. This projection is based on a worst case scenario of a robust cured grass crop; due to variations in weather and precipitation, a robust grass crop is not always present in the project area. Firefighters with only hand tools would be effective in over half of the project area, as flame lengths are expected to be less than 4 feet in 56% of the area. Additionally, the proposed action is expected to limit fire behavior to surface fire spread, a 17% reduction in the potential for crown fire activity. This reduction in crown fire activity is due to the reduced flame lengths and the higher canopy base height that will result from the proposed action.

Table 3. Anticipated Effects of Treatment to Fuels and Fire Behavior by Percentage of the Project Area

Fuel Model	Pre-Treatment	Post-Treatment
102 - primary carrier of fire is grass	14%	14%
121 - grass (low load) and shrubs (1' high) combined	0%	4%
122 - grass (moderate load) and shrubs (1'-3' high) combined	4%	32%
142 - woody shrubs (moderate load; 1' high) and shrub litter	11%	11%
147 - woody shrubs (very high load; 4'-6' high) and shrub litter	32%	0%
165 - heavy forest litter with shrub or small tree understory	4%	0%
183 - moderate load of conifer litter; light load coarse fuels	1%	2%
184 - moderate load of fine litter and coarse fuels (small downed logs)	1%	0%
186 - moderate load of broadleaf litter	6%	34%
188 - moderate load of long-needle pine litter	28%	4%
Flame Length (feet)	**Pre-Treatment**	**Post-Treatment**
0 - 2	11%	35%
2 - 4	27%	21%
4 - 8	15%	44%
8 - 11	2%	0%
11+	45%	0%
Fire Type	**Pre-Treatment**	**Post-Treatment**
Surface	83%	100%
Passive Crown (Torching)	17%	0%

The anticipated emissions from prescribed fire activities are detailed in Table 4. For comparison, Table 5 details the anticipated emissions if the project area burned in a wildfire under very dry conditions. Prescribed fire implementation would rely on carefully designed prescriptions, a smoke management plan, and coordination with the North Coast Unified Air Quality Management District to limit the impacts of smoke. These considerations are often not possible during wildfires.

Table 4. Anticipated Emissions Outputs for Prescribed Fire

Pollutant	lbs/ac	tons/ac	metric tons/ac	total metric tons	CO_2 equivalent metric tons (for GHGs only)
CO_2	54437	27.22	24.70	987.97	987.97
CO	3089	1.54	1.40	56.06	
CH_4	153	0.08	0.07	2.78	199.93
NO_X	76	0.04	0.03	1.38	398.62
SO_2	34	0.02	0.02	0.62	
PM 2.5	282	0.14	0.13	5.12	
PM 10	333	0.17	0.15	6.04	
Total	58,404	29	27	1060	1587

Table 5. Anticipated Emissions Outputs for Wildfire (without treatment)

Pollutant	lbs/ac	tons/ac	metric tons/ac	total metric tons	CO_2 equivalent metric tons (for GHGs only)
CO_2	56092	28.05	25.45	1018.00	1018.00
CO	3493	1.75	1.58	63.39	
CH_4	171	0.09	0.08	3.10	223.45
NO_X	77	0.04	0.03	1.40	403.87
SO_2	35	0.02	0.02	0.64	
PM 2.5	313	0.16	0.14	5.68	
PM 10	369	0.18	0.17	6.70	
Total	60,550	30	27	1099	1645

The total greenhouse gas (CH_4, CO_2, and NO_X) emissions under prescribed fire conditions are 1,587 metric tons of CO_2 equivalent. The USFS provides the following guidance on considering greenhouse gas emissions and climate change in project-level National Environmental Policy Act analysis and documentation:

> It is not currently feasible to quantify the indirect effects of individual or multiple projects on global climate change and, therefore, determining significant effects of those projects or project alternatives on global climate change cannot be made at any scale (USFS 2009).

> Because greenhouse gases mix readily into the global pool, it is not currently possible to ascertain the indirect effects of emissions from single or multiple sources (projects). Also, because the large majority of Forest Service projects are extremely small in the global atmospheric carbon dioxide context, it is not presently possible to conduct quantitative analysis of actual climate change effects based on individual or multiple projects (USFS 2009).

However, it can also be noted that, by maintaining a reduced fuel load within the project area, the probability of future releases of higher levels of emissions at the height of the summer fire season can be reduced. Without implementing the proposed action, there is a higher probability of losing the stand to a high severity wildfire; there is an indirect benefit of maintaining a healthy stand of trees that can continue to sequester carbon dioxide.

Cumulative Effects

The BLM's Redding Field Office completed the Ewing Reservoir Broadcast Burn Environmental Assessment in 2012 and intends to use prescribed fire to treat fuels on approximately 300 acres of land adjacent to the USFS parcel. The combined effect of the projects will increase fire suppression capabilities, provide for firefighter and public safety, mitigate risk to communities and infrastructure, improve vegetation resilience, and improve wildlife habitat on a larger scale.

Coordination with the North Coast Unified Air Quality Management District and compliance with smoke management plans and burn permits should limit the combined effects of multiple projects in the area. This project's contribution to cumulative emissions will be relatively minimal and will be coordinated to occur under conditions with favorable dispersion.

With regard to greenhouse gas emissions, the USFS provides the following guidance:

> As GHG emissions are integrated across the global atmosphere, it is not possible to determine the cumulative impact on global climate from emissions associated with any number of particular projects. Nor is it expected that such disclosure will provide a practical or meaningful effects analysis for project decisions (USFS 2009).

Figure 1. Brush field within the Ewing parcel

Figure 2. Brush, oak woodland, and timber stand within Ewing parcel

Figure 3. Recently burned timbered portion of Ewing parcel

References

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